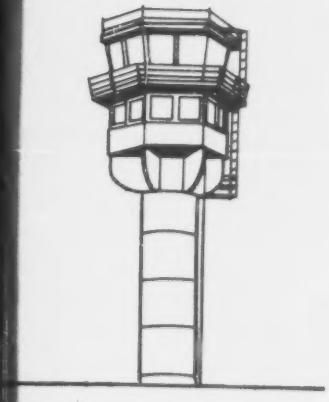
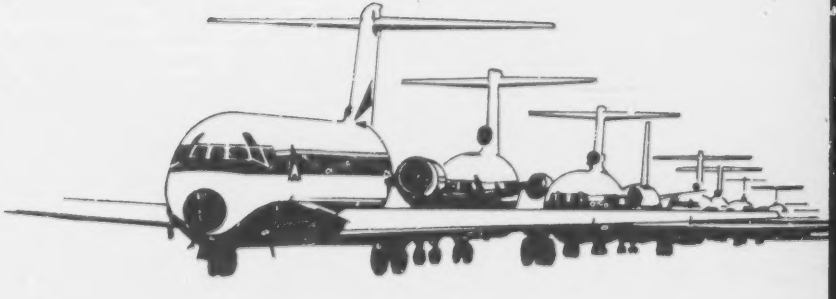
AIRPORT SYSTEM DEVELOPMENT





SUMMARY

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Office of Technology Assessment
Washington, D.C. 20510

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The Technology Assessment Board approves the release of this report. The views expressed in this report are not necessarily those of the Board, OTA Advisory Council, or of individual members thereof.

Foreword

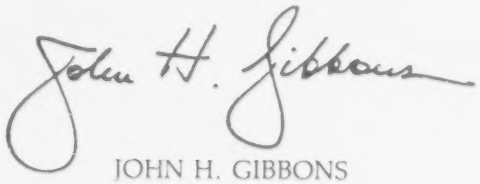
The United States has the largest and most technologically advanced system of airports in the world. These airports support an air transportation network that links all parts of the Nation to the rest of the world and enables over 300 million passengers each year to undertake journeys—many of great length—with ease, comfort, and safety. One measure of the excellence of this system is that over 98 percent of all airline flights arrive within 15 minutes of schedule.

Still, there is cause for concern about the future adequacy of the airport system. On one hand, there is need to accommodate expected growth in air travel demand at major airports, several of which are now experiencing severe congestion at periods of peak use. On the other, there is also need to assure access to airport facilities by private and business aircraft operators, who are fast becoming the predominant users of airports and the most active sector of civil aviation. Community concern about noise and land use limit the ability of airport planners and managers to provide additional facilities or, in some cases, to accommodate more traffic at existing facilities.

Undertaken at the request of the House Committee on Public Works and Transportation, this study examines present conditions and future needs of the Nation's airports, with emphasis on possible solutions to problems of operational capacity and air travel delay. The range of remedial actions considered includes improved airport and air traffic control technology, revised procedures for airport and airspace use, economic and regulatory measures to reduce demand during peak periods, and managerial approaches to make more efficient use of existing airport facilities. Special attention is given to issues of airport planning and funding methods at Federal, State, and local levels.

OTA was assisted in this assessment by an advisory panel reflecting a broad range of interests and expertise, ably chaired by Dr. Don E. Kash of the University of Oklahoma. OTA is greatly indebted to the advisory panel and to many others in the aviation community for their generous contributions. Their participation does not necessarily constitute consensus or endorsement of the content of the report, for which OTA bears sole responsibility.

One notable feature of this assessment is that it is a cooperative effort by the Office of Technology Assessment and the Congressional Budget Office, in which CBO provided detailed analysis of airport financial management, funding methods, and capital investment.



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OTA appreciates the valuable assistance and thoughtful comments provided by advisory panel members at many points during the assessment. OTA, however, accepts sole responsibility for the views expressed in this report.

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This assessment is a cooperative effort by the Office of Technology Assessment and the Congressional Budget Office. CBO's work, which forms an integral part of this study has also been published by them in *Financing U.S. Airports in the 1980s,* April 1984. OTA is particularly indebted to David Lewis, Richard R. Mudge, and Suzanne Schneider of CBO for their participation in this assessment.

*Through September 1983.
**After September 1983.

Airport System Development

The U.S. air transportation system has experienced enormous growth over the past 40 years. The number of people and the range of activities served by the air transportation system have expanded to include nearly every element in our society. In every category of business and private travel and in the shipment of freight by air, activity has grown to the point where the air transportation system has become both very large (in terms of number of aircraft, enplanements, people employed, annual revenue, and so on) and critical to the Nation's economic well-being.

In part, the growth of the air transportation system is due to Federal programs aimed at fostering civil aviation and subsidizing its development. A key ingredient in these programs has been the capital assistance provided the airport system. At the onset of World War II, a program of direct Federal aid to airports was undertaken with the motive of providing a strong network of airports that would contribute to national defense and be suitable for later use by civil aviation. In the postwar years, Federal involvement in airport development was broadened to achieve two other goals. The first was to build a national system of airports adequate to serve a growing industry and—somewhat later—to accommodate the jet aircraft introduced in the 1960s. By 1970, the prevailing view was that only a Federal program funded by revenues raised from taxes on air transportation would be capable of providing adequate airport facilities throughout the country. The second goal was to assure that the airport system be capable of meeting whatever demands users might be expected to make. Simply stated, Federal policy reflected the view that air transportation should not be constrained by airport capacity limitations. This has been an essential element in the Government's commitment to promoting aviation, and Congress has charged the Federal Aviation Administration (FAA) with responsibility to maintain a plan for orderly development of the airport system.

The Nation's air transportation system has now entered a new era, a period of basic reassessment and adjustment. It is an industry that is, at once, large and mature and yet fluid and rapidly changing. In the passenger sector, Americans from all walks of life take air travel as a given, and for long-distance travel, it is the preferred mode. Similarly, the general aviation sector (privately owned aircraft operated for business and personal use) is now large, diverse, and very active, with a fleet numbering almost 210,000 that ranges from small single-engine aircraft to large commercial-size jets. In terms of aircraft operations and activity at FAA air traffic control facilities, general aviation now accounts for half or more of all use of the airspace and is projected to grow at a faster rate than commercial aviation. In recent years, there has also been a rapid expansion of air cargo and parcel

Table 1.—U.S. Airport and Air Transportation Activity, 1982

Aircraft facilities:[a]	
Airports	12,596
Heliports	2,712
STOLports	65
Seaplane bases	458
	15,831
Airport ownership and use:[a]	
Publicly owned	4,805
Private, open to public	1,970
Private	9,056
	15,831
Domestic passenger enplanements (millions):	
Air carrier:	
Domestic	272.8
International	19.7
Commuter	17.1
	309.6
Domestic revenue passenger miles (billions):	
Air carrier	207.8
Commuter	2.3
	210.1
Civil aircraft fleet:	
Air carrier[b]	4,074
General aviation	209,799
	213,873
Aircraft operations (millions):	
Air carrier	9.1
Commuter and air taxi	5.1
General aviation	34.1
Military	2.3
	50.6
Hours flown (millions):	
Air carrier	6.7
Commuter	1.7
General aviation	36.4
	44.8
Air cargo (million tons):[c]	
Mail	1.2
Freight	2.4
	3.6

[a]Excludes Puerto Rico, Virgin Islands, and Pacific Territories.
[b]Includes commuter, air taxi, air travel clubs, and all-cargo service.
[c]1981 data.

SOURCE: Federal Aviation Administration and Civil Aeronautics Board data.

carriers. This sector of the air transportation system is developing into a whole new national network of fast and relatively low-cost transport for small, highly valued materials.

Recognizing the vital role that air transportation plays in the economy and the changes that the industry is experiencing since airline deregulation, Congress has charged FAA with formulation of a National Plan of Integrated Airport Systems. The need for this plan is driven by two factors. First, the United States now has a well-developed airport system, in many ways the envy of the world. This system must be maintained and expanded to accommodate continued growth. Second, there is a need to integrate air transportation more effectively into the overall transportation system. Airports are points where important linkages occur.

AVIATION DEMAND

The starting point for assuring adequate airport capacity is an understanding of both the size and nature of future demand. Projecting airport needs has always been difficult, and often controversial. Three factors have traditionally affected the forecaster's success.

First, projecting any type of demand is inherently complex and difficult. Demand is influenced by a wide range of factors—the future state of the

economy, new technology, government regulations, and decisions of private enterprise. At best, forecasting is an uncertain art.

Second, airports are locally planned and operated. While, in a sense, airports constitute a system, it is not a centrally managed and coordinated system. Each airport operator makes a continuing, and essentially independent, assessment of need in relation to expected demand and draws up plans to modify facilities and to expand capacity. Projecting airport capacity at the national level, then, involves estimating the consequences of hundreds of local decisions and actions that are not readily predictable.

Finally, if estimating demand and capacity were not difficult enough, there is little agreement on how to define need—except in the most general terms as an excess of demand over capacity that will result in delay. FAA has characterized the problem as follows:

> Capacity and delay are illusive concepts, surrounded by confusion and misunderstanding. A substantial part of this problem is that multiple definitions are interchangeably used and that incomplete data are collected by multiple sources for varying purposes. The problem is further compounded by the difficulty in determining cause-and-effect relationships from the data which are available.[1]

Recent studies by FAA and the aviation community have skirted the definitional problem by using delay rather than capacity as the basis for analysis. Delay is somewhat easier—albeit far from simple—to measure and has the added advantage of allowing straightforward calculation of delay cost, which is ultimately what persuades all parties of the need to make improvements.

In this report, OTA uses the term **capacity** to mean the complement of facilities at an airport and the procedures governing their use that collectively determine **the number of aircraft operations (takeoffs or landings) or the number of passengers that can be accommodated within any given period of time. Capacity, then, is a measure of rate.** Capacity is seldom constant, even at one airport. It varies according to weather conditions, operational characteristics of aircraft, equipment and devices installed at various locations on the airport, and several other factors that may change from time to time or place to place. As demand for service approaches the rate sustainable for any given set of conditions, queues of increasing length develop, and the passage of aircraft or passengers is delayed.

In OTA's view, the policy debate on airport capacity and needs is all too frequently impeded by disagreements on inherently murky technical and definitional issues. **Pragmatically, however, there appears to be a rough but sufficient consensus that the concept of "acceptable" delay is an appropriate standard for judging the adequacy of airport capacity.**

How much delay is acceptable? This is a judgment involving three factors. First, some delay is unavoidable since it occurs for reasons beyond anyone's control—wind direction, weather, aircraft performance charac-

[1] *Airfield and Airspace Capacity/Delay Policy Analysis*, FAA-APO-81-14 (Washington, DC: Federal Aviation Administration, December 1981), p. 9.

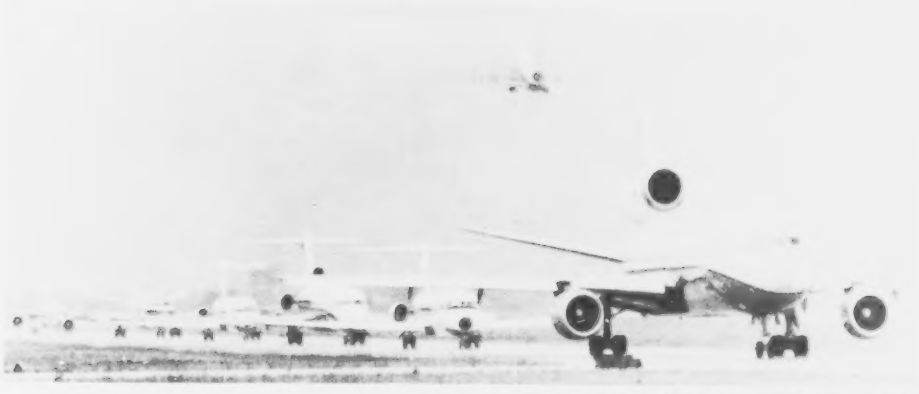

Photo credit: Federal Aviation Administration

teristics, the randomness of demand for service. Second, of the delay that is avoidable, some might be too expensive to eliminate—i.e., the cost of remedial measures might exceed the potential benefit. For example, the cost of building and operating a second runway to accommodate high traffic demand for a few hours from time to time during the year might far outweigh the benefit of no delay at these extreme peak periods. Third, even with the most vigorous and successful effort, the variable nature of demand and capacity means that there will always be some delay greater than some "acceptable" length for some airport users. Thus, acceptable delay is essentially a policy decision about the tolerability of delay being longer or more frequent than some specified amount, taking into account the technical feasibility and economic practicality of available remedies.

THE DELAY PROBLEM

Delay is a particularly pernicious problem because delay at a given airport is not contained at that airport. It ripples outward to cause congestion and delay at other airports. Delay has systemic effects, such that any air carrier airport with chronic delay problems must be a national concern. Similarly, as we will discuss later, delay may stem from any of several components of the airport and air transportation system: the runway layout, airline scheduling, the traffic mix, air traffic control, noise rules, terminal building design, baggage handling and ticketing operations, landside access, and so on.

Although OTA finds that it is not possible to make a precise projection of the extent, timing, and location of delay, **the Nation clearly faces worsening delay problems at some major airports. At present, unacceptable delay occurs at certain times of day, week, or season—especially in adverse weather—at 10 or so of the largest airports. Unless capacity is expanded or utilized differently or unless demand is managed, delays could spread to many more high-volume air carrier airports by 2000.** FAA, for exam-

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ple, projects that flights at as many as 60 major air carrier airports will encounter unacceptable delays by then if no remedial action is taken (table 2). Capacity problems could also emerge at 40 to 45 general aviation airports by that same time.[2] The capital investment to maintain the present system and to provide the additional airport capacity necessary to hold delay at major airports to acceptable levels over the next 10 years has been estimated by FAA at $7.5 billion to $11.5 billion.

GUIDELINES FOR RESPONSE

Given existing and anticipated airport delay problems and the inability to predict their exact nature, location, and timing, **Federal airport policy must be flexible and varied in the manner and timing of response to emerging problems. Further, since Federal policy sets the boundaries of solutions that may be applied, it should encourage the same flexibility on the part of airport operators and airspace users.** At one extreme, Federal safety standards, such as those governing the separation of aircraft in the landing pattern, determine the number of aircraft that can be accommodated during any given period of time. Revision of these standards, which might be made possible by new technology, could increase the rate of operations and provide relief at some airports at certain times and under certain conditions. At the other extreme, the formula used to allocate Federal airport grants can either constrain or encourage flexibility at airports, depending on how it is applied and the conditions surrounding the award of funds.

The starting point for any discussion of flexibility in addressing the delay problem must be the recognition that airport and airspace planning and management, though conducted on many levels, has an impressive record of solving problems through experimentation and innovation. When new approaches work, the rest of the system quickly assimilates and uses successful responses to delay.

Some examples will serve to illustrate the creativity of decisionmaking and response in the national airport system. In reviewing the history of the airport capacity problem, OTA found several past studies that projected a crisis of airport capacity in which demand would completely overwhelm existing facilities. Yet airports, working with FAA and airline management and aided by advancing technology, have repeatedly modified designs and procedures and continued to accommodate new demand. Improved guidance and surveillance systems and revised air traffic control procedures have reduced the effects of adverse weather on runway capacity, allowing higher and more nearly uniform rates of operation to be sustained in all but the most extreme conditions. Computerized flow control techniques have been applied to manage traffic on a regional and national basis, metering arrivals and departures in a way that lessens fuel consumption and avoids stacks of aircraft in holding patterns at congested major airports.

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[2]*National Airspace System Plan* (Washington, DC: Federal Aviation Administration, April 1983).

Table 2.—Airports Forecasted to Have Airside Congestion[a]

Commercial service	General aviation
1981	**1981**
Chicago O'Hare (IL)	Fort Worth Meachum (TX)
Denver Stapleton (CO)	Teterboro (NJ)
Detroit Metro (MI)	Van Nuys (CA)
Los Angeles International (CA)	**By 1985**
Philadelphia International (PA)	Baltimore Glenn L. Martin (MD)
San Francisco International (CA)	Farmingdale Republic (NY)
St. Louis Lambert (MO)	Kansas City Downtown (MO)
Washington National (DC)	Scottsdale Municipal (AZ)
By 1985	**By 1990**
Long Beach Dougherty (CA)	Anchorage Lake Hood (AK)
Santa Ana John Wayne (CA)	Everett Snohomish County (WA)
Palm Beach International (FL)	Houston Lakeside (TX)
By 1990	Killeen Municipal (TX)
Anchorage International (AK)	Manassas Municipal (VA)
Atlanta Hartsfield (GA)	Mesa Falon (AZ)
Baltimore-Washington International (MD)	Morristown Municipal (NJ)
Birmingham Municipal (AL)	Novato Gnoss (CA)
Boston Logan (MA)	Torrance Municipal (CA)
Dallas-Fort Worth (TX)	Vero Beach Municipal (FL)
Houston Hobby (TX)	**By 2000**
Houston Intercontinental (TX)	Anchorage Merrill (AK)
Las Vegas McCarran (NV)	Aurora State (OR)
New York Kennedy (NY)	Beverly Municipal (MA)
New York La Guardia (NY)	Carlsbad Palomar (CA)
Prescott Municipal (AZ)	Chicago Palwaukee (IL)
Raleigh-Durham (NC)	Dallas Addison (TX)
By 2000	Denver Arapahoe County (CO)
Burbank Glendale Pasadena (CA)	El Monte (CA)
Charlotte Douglas Municipal (NC)	Fort Lauderdale Executive (FL)
Eugene Mahlon-Sweet (OR)	Fullerton Municipal (CA)
Daytona Beach (FL)	Goodyear Phoenix-Litchfield (AZ)
Greensboro High Point-Winston-Salem (NC)	Greeley Weld County Municipal (CO)
Indianapolis International (IN)	Hayward Air Terminal (CA)
Lafayette Regional (LA)	Hartford Brainard (CT)
Memphis International (TN)	Hillsboro-Portland (OR)
Norfolk International (VA)	Houma Terrebonne (LA)
Oakland Metropolitan (CA)	Livermore Municipal (CA)
Orlando International (FL)	Miami New Tamiami (FL)
Oxnard (CA)	Minneapolis Crystal (MN)
Phoenix Sky Harbor (AZ)	New Orleans Lakefront (LA)
Providence T. F. Green (RI)	Norwood Memorial (MA)
Reno Cannon International (NV)	Palo Alto (CA)
San Antonio International (TX)	Philadelphia North (PA)
San Diego Lindbergh (CA)	Phoenix Deer Valley Municipal (AZ)
San Jose Municipal (CA)	Riverside Municipal (CA)
Sarasota Bradenton (FL)	San Carlos (CA)
Tucson International (AZ)	Santa Rosa Sonora County (CA)
White Plains Westchester County (NY)	Seattle King County (WA)
	Waukegan Memorial (IL)

[a]FAA considers an airport to be congested when traffic reaches 160 percent of Practical Annual Capacity or when significant constraints are expected because of physical limitations on airport use.

SOURCE: Federal Aviation Administration.

Problems of capacity and delay have also been addressed in other, less dramatic, but equally effective ways. For example, additional gates, and therefore new capacity, have been added by parking aircraft nose-in rather than parallel to concourses, which was the original pattern at many air-

ports. Delays within the terminal have been reduced by preassignment of seats at the time reservations are made. Extending this concept, some air carriers now issue all boarding passes, both departing and returning, during a single visit to the ticket counter or departure gate, or at the time the ticket is purchased through a travel agent.

Finally, through the increased use of hub-and-spoke scheduling, air carriers have been able to increase service, especially to smaller cities, and yet avoid the congestion of a large airport by locating their hub of operations at an airport with ample reserve capacity. Illustrations of this approach are Piedmont's new hubs at the previously underutilized Dayton and Baltimore airports, Republic's new hub at Memphis, and Western's at Salt Lake City.

AIRPORT FUNDING: ISSUES AND OPTIONS

While there are many aspects of Federal policy that affect airport system development, there is perhaps none so powerful as that pertaining to capital grants for improvement or expansion of airport facilities. The policy options considered by OTA concentrate therefore on the rationale of Federal funding and the amount of capital aid to be provided.

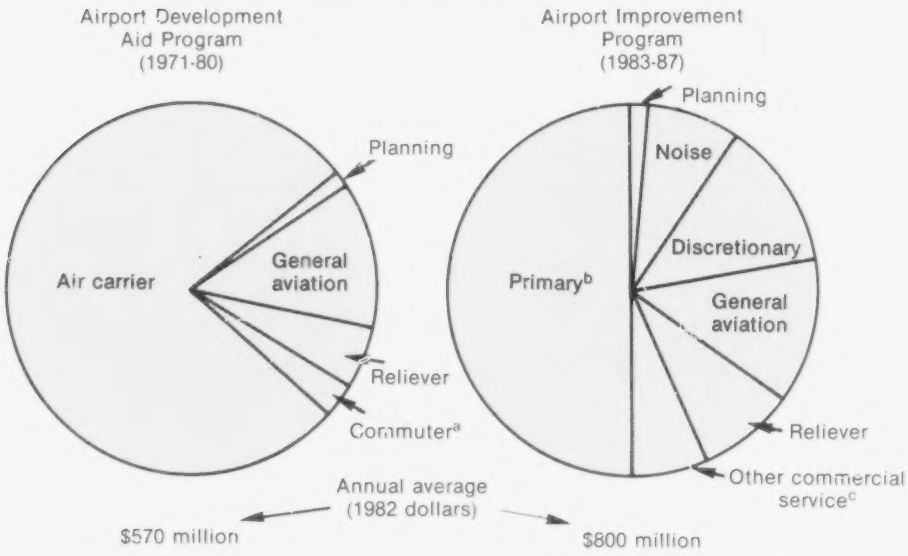
Present Policy

The Airport Improvement Program (AIP), enacted by Congress in September 1982, as Title V of the Tax Equity and Fiscal Responsibility Act of 1982 (Public Law 97-248), is essentially an extension and refinement of the Airport Development Aid Program (ADAP) which existed from 1971 to 1980. Under AIP, 50 percent of the annual airport appropriations from the Airport and Airway Trust Fund are to be distributed to about 280 primary commercial service airports on the basis of passenger enplanements. Nonprimary commercial service airports (also numbering about 280, each enplaning between 2,500 and 31,000 passengers annually) are to receive 5.5 percent of available AIP funding each year, but without annual apportionments. Projects for noise abatement, for major improvements at primary airports not covered by enplanement apportionments, and for reliever airports (including for the first time privately owned public-use airports) are to be funded on a discretionary basis in amounts up to 31.5 percent of available funds (made up of 8 percent for noise control, 10 percent for relievers, and 13.5 for other discretionary outlays). Grants amounting to 1 percent of annual outlays are available to State, regional, and metropolitan agencies for airport system planning. The remaining 12 percent is allocated to general aviation airports and distributed among States by a formula based on area and population (fig. 1).

Alternatives to Present Policy

In advancing alternatives, OTA does not contend that present policy is unsatisfactory or that it would be an inappropriate course for future years. The present Airport Improvement Program, tempered by the previous 10

Figure 1.—Distribution of Federal Airport Aid



[a]1976-80 data only.
[b]Airports enplaning at least 0.01 percent of airline passengers annually.
[c]Airports enplaning 2,500 to 31,000 passengers annually.

SOURCE: Office of Technology Assessment based on FAA data.

years of experience with ADAP, seeks to provide a balanced and sufficient program of aid that is consistent with the longstanding Federal policy of encouraging and fostering civil aviation.

The rationale of the options presented here is that, if it is desired to redirect Federal airport policy, there are three basic avenues that might be taken. The first, embodied in the defederalization option, is that the primary test to be applied in the distribution to aid for airports is financial self-sufficiency. The second line of departure from present policy is that a more restrictive definition of Federal interest could be applied. Two options of this sort are considered: selective aid only to those airports that serve to make up a national air transportation network and—more restrictive still—aid for navigation and air traffic control but none for airports themselves. The third shift of policy, State administration, would not affect the amount and type of airport aid afforded under current policy, but it would place responsibility for distribution of this aid in the hands of State and local agencies instead of the Federal bureaucracy. (None of these options would change the present method of support for air traffic control system modernization or for funding FAA operational and maintenance activities. FAA's regulatory and safety functions related to airport operation would likewise be unaffected.)

Defederalization

Defederalization refers to withdrawal of Federal capital assistance from airports that are capable of self-support—roughly 70 of the largest commercial service airports. These airports would be expected to finance future

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Table 3.—Alternative Federal Airport and Policies

Airport category	Number of airports	Average annual expenditures (1985-89) (millions, 1982 dollars) Present policy[a]	Defederalization[b]	Selective aid[b]	State administration Enplanement[c]	State administration Block grant[d]
Large[e]	24	$280		—	$280	—
Medium[e]	47	80	—	—	75	—
Other commercial service[e]	489	85	$120	$140	45	$133
Reliever	219	80	115	130	—	133
General aviation	2,424	95	130	—	—	133
Other aid	—	180[f]	75[g]	75[g]	—	—
Total	3,203	$800	$400	$345	$800	

[a]Assumes that AIP outlays and the distrubtion formula currently authorized through 1987 are continued.
[b]Assumes currently authorized levels of aid plus equal distribution of $108 million in discretionary grants for airport categories that remain eligible for Federal aid.
[c]Assumes that half the current level of aid would go to large, medium, and other commercial service airports based on enplanements, with large airports receiving 70 percent, medium 20 percent, and other commercial service 10 percent.
[d]Assumes that States will distribute block grants about equally among the other commercial service, reliever, and general aviation categories.
[e]Large airports enplane more than 1 percent of all passengers; medium more than 0.25 percent. The other commercial service category includes 210 small primary airports (0.01 to 0.25 percent of annual enplanements) and 279 nonprimary airports enplaning at least 2,500 passengers annually.
[f]Made up of $108 million for discretionary grants, $64 million for noise projects, ad $8 million for planning.
[g]Grants for noise projects and planning at currently authorized levels.

SOURCE: Office of Technology Assessment.

capital improvements from their revenues, either retained earnings or revenue bonds. Federal grants to other commercial service airports and general aviation airports could be made available in roughly the same amounts as under present policy, or they could be increased by redirecting to these airports some or all of the moneys now channeled to the larger airports that would be defederalized. An issue historically linked to defederalization, but not an essential feature of the policy, is whether to grant to the defederalized airports the right to levy a passenger facility charge (head tax). Some airport operators have indicated that they would not be able to make up for the loss of Federal grants by increasing landing fees or other airline charges or by going to nonairline sources. Others believe that such means would be adequate. While it is by no means certain that the right to impose a passenger facility charge is necessary to make this policy workable, the issue would have to be addressed if only in order to resolve how much freedom and flexibility defederalized airports should have in the absence of direct Federal support.

Restricted Federal Interest

Selective Aid for Airports.—This alternative, based on a more restrictive definition of national interest in airport development, would limit Federal grants to those airports that provide commercial air service and to a selected set of general aviation reliever airports whose function is to provide alternatives to congested commercial service airports in major metropolitan areas. This policy option would create a national airport system akin to the interstate highway system, in which commercial service airports and general aviation reliever airports would be defined as the "Federal por-

tion." The maintenance and upgrading of all other airports would become a State and local responsibility (like State and local highways), either wholly or with the possibility for Federal grants or loans in special cases where the national interest is affected. To compensate for decreased Federal and increased State responsibility for funding, some aviation taxes now imposed nationally might be transformed into State taxes or user fees.

No Federal Aid for Airports.—In effect, this would be a return to the Federal policy that existed before World War II. Under the so-called "dock" concept, airports (like seaports) were regarded as facilities that should be built and maintained by municipalities since they serve primarily local economic interests. The Federal Government's responsibility would be limited to providing air navigation and traffic control facilities, charting airways, furnishing weather services, regulating safety, offering technical assistance, and the like. The costs of these Federal services could be defrayed either by General Fund appropriations or by the present user taxes, but at a reduced rate. All the funds needed for capital projects at airports would have to be obtained by some combination of airport fees, grants from State and local authorities, and loans from private investors in the form of revenue or general obligation bonds or other such indentures.

State Administration

Under this policy, the Federal Government would transfer responsibility for planning, funding, and administering airport capital programs to State aviation agencies or departments of transportation. In the interest of economic efficiency, uniformity, and consolidation of administrative costs, Federal taxes could still be imposed on airport and airways system users, but the revenues would be turned back to States as entitlements for commercial service airports based on enplanements and as block grants based on various indicators of aviation activity (enplaned passengers, number of airports, aircraft registrations, fuel sold, population, area, etc.). It would be up to the States to supplement these revenues with other aviation taxes, as they do now, but perhaps at higher rates. The Federal Government might also retain some authority to set guidelines for State administration and for airport eligibility, purposes of expenditure, or local participation. The Federal Government would also retain all functions related to safety, operational procedures, and airport certification. All air traffic control facilities (including those on airports) would continue to be built and operated by FAA.

THE FEDERAL ROLE

In promoting aviation by providing abundant capacity at low cost to airport and airspace users and by underwriting research and development in airport and airspace technology, the Federal Government in effect sub-

sidized airlines, general aviation, aircraft manufacturers, and local enterprise. It is important to consider the rationale for this Federal involvement and whether it is still appropriate.

In the earliest days of aviation, the aim of Federal policy seems to have been to foster a fledgling industry for reasons of national defense and development of an economically valuable new mode of transportation. Without this support, aviation might have lagged or developed in a different direction. In the years after World War II, the rationale of civil aviation as a buttress of national defense became less important, and considerations of the national economy and regional development came to predominate. They still do. Aircraft manufacturing and the aviation industry are important contributors to the balance of trade. Available, efficient, and low-cost air travel stimulates all sectors of the economy. An airport is an important economic resource to a community, both in and of itself and because it can be used to leverage additional highly desirable development. From this point of view, aviation is a general boon to the economy, and the Federal Government could be considered justified in pursuing the present policy.

On the other hand, aviation is no longer immature, underdeveloped, and struggling. Despite vicissitudes that affect it along with the rest of the economy, aviation is a robust industry that is capable of supporting itself. Is a strong Federal presence still required? Opinion is sharply divided on this question, but it is certainly appropriate to reexamine the nature of the social and economic contract between the Government and the aviation community to see if mutual interests could be better served in other ways. In so doing, Congress may also wish to consider whether the goals historically pursued in Federal airport programs are still appropriate.

One of those goals has been to build a national system of airports. That system is now virtually complete. When the question of Federal aid to airports was first raised 50 years ago, there were relatively few airports, except in major cities, and even these were primitively equipped and often hard to reach. Federal assistance was sorely needed to build the infrastructure for a burgeoning aviation industry. Today, there is about one airport per county, capable of handling nearly any type of aircraft and providing ready and almost universal access to the air transportation network. While some additional airports are needed, they are rather few and would serve primarily to ease capacity problems in major metropolitan areas where there is high growth in aviation activity. **The dominant concern now appears to be not expansion of the airport system but preservation of what is in place and upgrading those parts where demand now exceeds, or is anticipated to outgrow, capacity.**

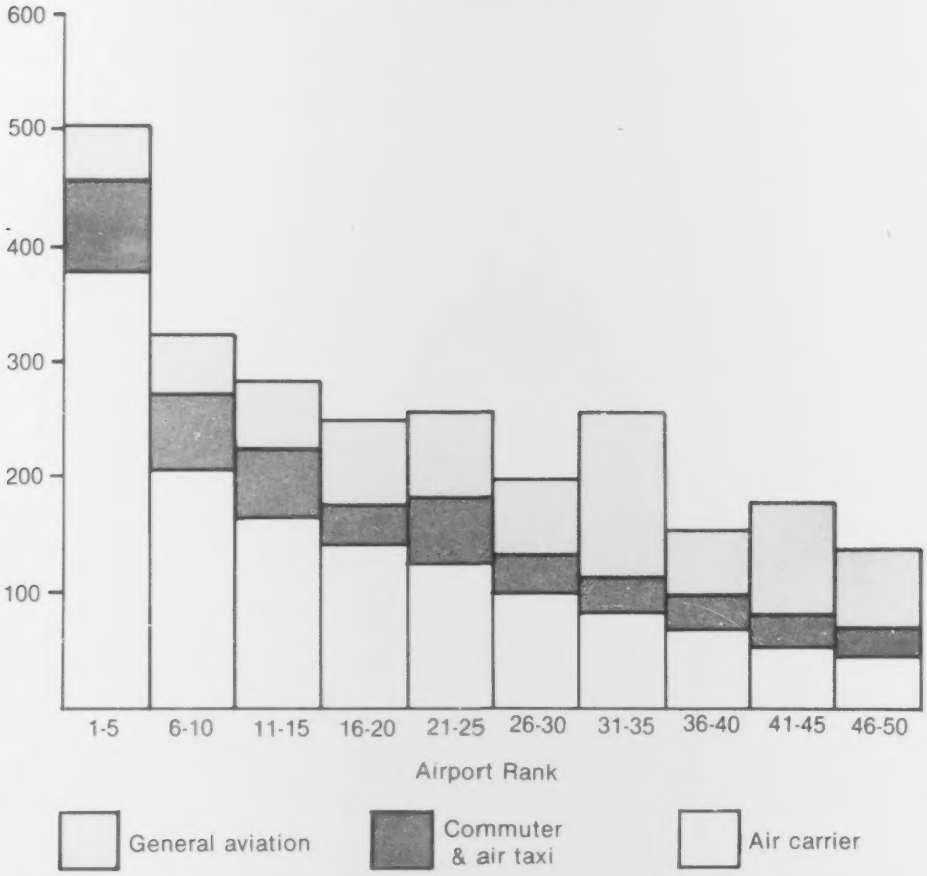
Another goal of Federal policy has been to provide facilities sufficient to accommodate all potential users, such that the growth of no sector of civil aviation be constrained by lack of airport capacity. While much of the Federal Government's support has gone to airports serving air carriers, private aircraft owners have also received substantial benefits—both from airports built expressly for general aviation use and from essentially unrestricted access to air carrier airports. At all but the very largest, general aviation accounts for a third to half of the traffic at the top 50 airports

(see fig. 2). However, fuel taxes and landing fees paid by general aviation make up only a small part of the costs of these facilities, which are built and maintained with public funds. **Some observers question whether it is appropriate, in a time of increasing demand for capacity at major metropolitan airports, to continue accommodating general aviation at these locations, especially if this means further investment of public funds for new capacity.** Even if it is concluded that access to these airports by general aviation is still appropriate, there remains the question of whether private and business aircraft owners should contribute a greater share of the funds needed to build and operate the airports they use.

AIRPORT FINANCIAL MANAGEMENT

Analysis by the Congressional Budget Office (CBO), conducted in cooperation with OTA on this assessment, found few funding problems at

Figure 2.--Activity at the Top 50 Commercial Airports
(ranked by air carrier operations, fiscal year 1982)



SOURCE: Federal Aviation Administration, *FAA Air Traffic Activity, FY 1982*, September 1982.

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large and medium airports, which serve over 90 percent of passenger traffic. **These airports are in good financial condition and enjoy sufficient, often ample, revenues to assure their creditworthiness in the municipal bond market (table 4). There has never been a default on an airport bond issue—an unblemished record that further enhances airports' reputation as soundly financed and managed enterprises.**

The evidence seems compelling that airports where congestion and delay are of greatest concern are presently capable of paying for most or all modification and expansion costs from their own resources. Availability of capital for expansion and improvement is not a major problem. However, there are legal, contractual, and budgetary constraints that, in some cases, deny these airports flexibility in how funds may be used.

First, as a general rule airports cannot, by local statute or contractual agreement and by specific Federal limitation in the Airport and Airway Improvement Act of 1982,[3] make a profit or raise more revenue than needed for short-range purposes. For each fiscal accounting or budget period, costs and revenues must be balanced. Airports typically cannot accumulate capital far in advance of planned expenditures. Denied this internally generated capital, airport managers can often find themselves operating in funding straightjackets. In a similar vein, airport managers (because of local statute or contractual agreement) may have limited authority to transfer funds from one budgetary category to another—a further constraint on their ability to respond flexibly to emerging needs.

[3]Public Law 97-248, Title V, sec. 511(a)(12).

Table 4.—Projected Airport Capital Needs and Sources of Funds (millions, 1982 dollars)

Airport category	Annual needs (1984-93)[a]	Annual grants	Bond sales[b]
Federal aid:[c]			
Large[d]	$450-$650	280	$ 689
Medium[d]	200-350	80	224
Other commercial service[d]	400-450	85	93
Reliever	100-150	80	8
General aviation	400-450	95	6
Other federal aid[e]	—	180	—
State aid[f]	—	200	—
Totals	$1,550-$2,050	1,000	$1,020

[a]Projections provided by CBO. Low estimates are derived from FAA National Airport System Plan; high estimates are from preliminary unpublished needs analysis for National Plan of Integrated Airport Systems.
[b]Based on average annual sales for 1978-82.
[c]Based on the outlays and distribution formula currently authorized in the Airport Improvement Program through 1987.
[d]Large airports enplace more than 1 percent of all passengers; medium more than 0.25 percent. The other commercial service category includes 210 small primary airports (0.01 to 0.25 percent of annual enplanements) and 279 nonprimary airports enplaning at least 2,500 passengers annually.
[e]Made up of $108 million inr discretionary grants, $64 million for noise projects, and $8 million for planning.
[f]Based on average outlays by States in recent years for all purposes, primarily for small airports.

SOURCE: Office of Technology Assessment, based on CBO and FAA data.

Whatever the character of future Federal funding, consideration should be given to measures that will increase the flexibility with which funding may be applied to needs. There is reason for concern about the direction that this aspect of Federal funding has taken in the recent legislation establishing the Airport Improvement Program (AIP). For example, the 1982 Act increased the number of categories in the funding formula from four to seven, with each category allocated a fixed percentage of annual Trust Fund outlays. The effect is more, rather than less, rigidity for airports attempting to deal with delay problems.

At present, most capital investments at those airports facing delay problems are funded through the bond market and retained earnings. Federal funding can, however, be critical in filling gaps or in supporting those projects for which airport users or local governments are unwilling to pay—noise abatement is one area where Federal aid is particularly important. One story may illustrate this gap-filling role. At one airport, the key to obtaining approval for a bond issue was drawing up a detailed plan for expansion and a preliminary design of the facilities to be added. Local funding, however, was not available for this first phase. A Federal grant filled the gap and allowed the project to go forward.

AIRPORT DECISIONMAKING

As the previous discussion suggests, the decisionmaking process associated with efforts to reduce airport delay is complex and frequently difficult. Certainly in the case of capital projects, but in many other capacity-related decisions as well, a carefully balanced coalition of interests must be built before actions can be taken to mitigate delay. In general, building this coalition requires that airport managers negotiate with three groups: airport users, the Federal Government (FAA), and local political leaders and interest groups.

The most important airport users have been the major air carriers. Although the specific legal agreements between air carriers and airports vary greatly, the general outlines have a common character. It has been the custom for airports and air carriers to formalize their relations with long-term use agreements covering periods of 20 to 25 years or more. Under many of these agreements, air carriers assure that they will provide financial support for airport construction, often with the stipulation that fees and rents can be adjusted upwards or downwards as necessary to cover operating costs and debt service. As a quid pro quo for agreeing to underwrite capital investment, airlines have often been accorded a deciding voice in the approval of airport expansion and improvement. **In some cases, capital projects have been delayed or not undertaken at all since the express consent and support of air carriers representing the majority in interest could not be obtained.**

Airport managers must also obtain support or approval from local nonaviation interests—municipal or county officials who must approve construction and financing, governments of surrounding jurisdictions that may

be affected, and citizen groups concerned with airport impacts (e.g., noise, highway traffic, or competing forms of land use). The number of local authorities and public interests can be large. The decisionmaking process is complex, often arduous, and the coalitions are nearly always fluid. Agreements reached with one set of elected officials can be reversed with a new election or simply with the passage of time and the emergence of new issues. Similar unpredictability pervades relations with nongovernmental interests. Building and maintaining the coalition necessary to design and carry out airport capacity improvements is a continuous and demanding process. **At the local level, particular attention should be paid to improving and facilitating the coalition-building process,** which is an essential ingredient in responding to airport capacity needs.

From this, it is apparent that the airport operator often does not have control of the airport's destiny. For example, in the case of city- or county-owned airports, the governing body may have other interests and priorities that conflict with those of the airport. Within the local political arena, airports must compete with other projects for the attention and approval of city councils, county supervisors, zoning commissions, and planning boards. Although the airport may be an important economic asset for the community, it also generates problems that may be difficult and expensive to solve.

Another difficulty is that the rules under which airports operate are now in a state of change and confusion. The traditional relationships with air carriers and the procedures for allocating resources and establishing fees developed in an era of close Federal regulation of the airlines and rapidly growing demand for air travel. Airlines have been deregulated and now

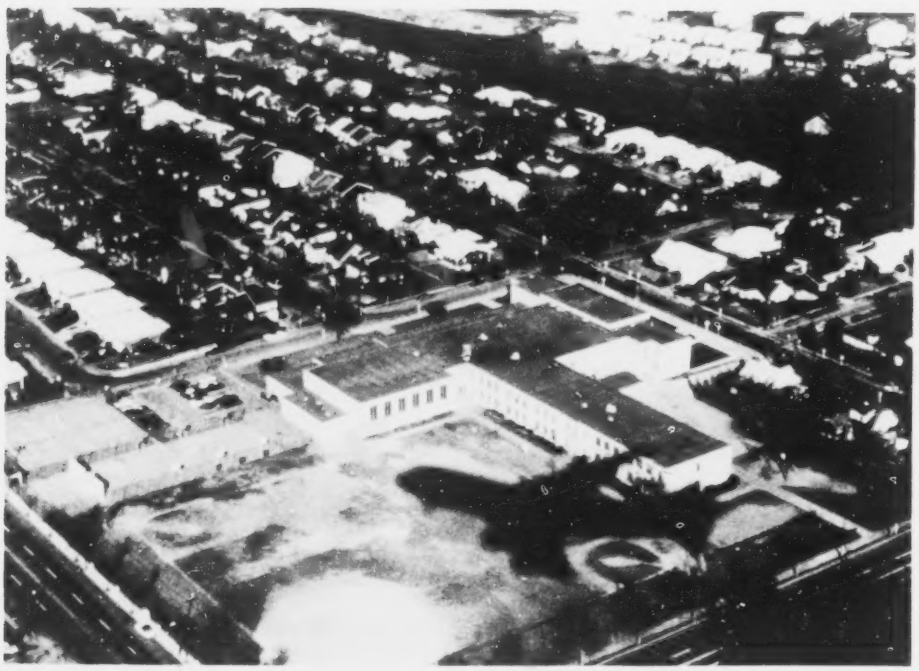

Photo credit: Dorn McGrath, Jr.

enjoy wide latitude in selecting airports and routes to serve. The growth of demand slowed with the recession but now seems to be rebounding, at least temporarily. The institutional structure and industry organization, however, have not yet wholly adapted to today's more fluid market conditions. This inertia is particularly evident in the long-term contractual agreements between airports and airlines, many of which still run for another 15 to 20 years.

Institutional arrangements also affect the process of airport planning and may hinder the search for solutions that would be more beneficial or efficient for the airport system as a whole. Individual airport operators and planners are principally concerned with the local situation, often the needs of one airport. In many cases, there is no effective institutional mechanism for taking actions, such as balancing traffic among two airports or developing reliever facilities, that might benefit the metropolitan area as a whole. In only a few cities does it appear that airport authorities have the freedom and power to conceive and implement plans that are greater than local in scope.

These factors—the airport manager's lack of control over airport decisions, an outmoded institutional structure, and impediments to regional planning—are all apparent in the matter of airport noise. Noise is generated by aircraft, chiefly large jets operated by air carriers. Encroachment of residential and other noise-sensitive development around the airport results from investment decisions by corporations and individuals. The policies permitting this development are set by local planning boards and zoning commissions. **Yet, it is the airport operator who bears liability for noise damages. However, his authority and freedom of action to protect himself from this liability are severely limited, and many of the possible recourses conflict with antitrust law, the commerce clause of the Constitution, the Federal prerogative to control air traffic, or scheduling requirements of air carriers.**

RELIEF OF CAPACITY AND DELAY PROBLEMS

Several proposed methods for reducing delay or alleviating congestion have been investigated by OTA. They include new technology and airspace use procedures for increasing the volume or rate of traffic that can be handled, managerial techniques for making better use of existing capacity, and regulatory or economic methods for channeling demand or affecting its distribution by time of day or among neighboring airports. The findings presented below are grouped according to the part of the airport affected: airside, terminal, or landside. **In general, OTA finds that congestion and delay occur at all three locations and that—while airside relief measures have customarily received the greatest attention from FAA, air carriers, and even many airport managers—terminal and landside problems are also severe and have an equally significant effect on delays experienced in air travel.**

Photo credit: U.S. Department of Transportation

Airside Problems

Delays on the airside occur in all phases of airport operation: landing, takeoff, movement on the ground, aircraft servicing, and gate activities. Since the components of the airside—the airspace surrounding the airport, as well as runways, taxiways, aprons, and passenger gates—are operationally linked, delay at any point affects the rate of flow at others and impairs utilization of the airport overall. Delays can occur at any time, but they are typically most acute when visibility is reduced and pilots and air traffic controllers must rely on electronic navigation and surveillance devices and special procedures (Instrument Flight Rules) to provide an extra margin of safety.

Demand Management

Traffic at airports is characterized by peaks and valleys, created in large measure by airline scheduling practice, but also due to the preference of people to travel at the beginning and end of the business day. One way to reduce congestion at these peak periods would be to shift part of the traffic to other times, thus making it possible to accommodate daily demand within the existing capacity of the airport but without extreme morning and evening delays.

There are two basic approaches to accomplish this demand management: 1) economic actions to alter the price of access for airport users according to time of day or level of demand, and 2) regulatory or administrative actions to limit the number or type of flights that will be accommodated. Either approach would have the same general effect—demand would be spread

more evenly across the day—but there would be some important differences. Regulatory measures would spread aircraft operations and take pressure off the runways, but they probably would not relieve terminal and landside congestion since they would not affect passenger preferences on travel time, and airlines would compensate for the reduction in flights at peak hours by operating larger aircraft to satisfy this demand. Economic measures would be likely to affect passenger volume as well as aircraft operations since they would discourage use of the airport during peak hours.

All economic approaches use the mechanism of price to modulate demand. One method is to price airport access according to the full cost of providing service—so-called **compensatory pricing** (or average-cost pricing), which charges each user a prorated share of the cost of building, operating, and maintaining aeronautical facilities. Less than half of large and medium airports set landing fees on this basis today, and if this approach were universally adopted, the effect could be to raise user costs, which would cause some to divert to other (less costly) times or locations. This could reduce the general level of demand at the airport charging higher fees and perhaps reduce traffic peaks as well since it would operate selectively on those whose use of the airport is discretionary. A second approach, targeted specifically at reducing traffic peaks, is **congestion cost pricing** (or marginal-cost pricing), whereby the price of access is based either on the cost of providing the extra facilities needed in peak periods or on the costs that such use imposes on others seeking access to the airport at the same time. Either way of establishing a congestion cost price presupposes that there is some accurate and generally acceptable way to determine these costs; and since there is not, they would be controversial in their application. A third method that circumvents this difficulty is the **slot auction,** in which the right to use the airport at a certain time is sold to the highest bidder. In this way, the free market determines the cost, which is simply what users are willing to pay based on their perception of the value of airport access at any given time.

There are several regulatory or administrative techniques to manage demand for airport service. All rely on a policy decision by some authority—local, regional, or national—about the number or type of aircraft operations permissible within the limit of some given capacity or acceptable amount of delay. One method is to set a ceiling on airport operations (takeoffs and landings) or on passenger volume. Slot allocation—reservations to to use the airport at a specific time—is a similar method aimed specifically at controlling peak traffic. Slot restrictions were imposed by FAA at 23 major airports in the aftermath of the air traffic controllers' strike, but they have since been lifted at all but four. Operational ceilings and slot reservations are generally unpopular with airlines and private aircraft operators because they restrict access to airports at the most desired times, and FAA is reluctant to adopt them as regular policy. Still, they are an effective way to manage demand at high-volume airports, providing there is an acceptable way of deciding which users will get the limited number of slots.

A somewhat more acceptable method, although not without controversy, is flow control. This is the computer-aided air traffic management procedure now used by FAA whereby the volume of traffic to and from the airport is adjusted dynamically in response to overall regional or national demand. Flow control thus does not restrict airport access for any one user, it simply adjusts arrival and departure times throughout the system so that delay occurs in less costly ways (usually on the ground at the departure airport or en route rather than in a holding pattern at the destination airport).

Another approach to maximize the efficiency of airport use would be to impose restrictions on the type of aircraft that will be accommodated. By this method, flights with only a few passengers (e.g., general aviation or business aircraft) would be diverted from major air carrier airports to alternate sites (reliever airports) where they can be accommodated without causing delay to flights carrying larger numbers of passengers.

Technology

Many in the aviation community find demand management distasteful because it imposes restrictions on airport access at the most desirable locations and times. They also consider demand management to be contradictory to basic Federal aviation policy, which has been predicated on the the concept of full access to the airport and airspace system by all users—the "first-come, first-served" principle. In their view, a more acceptable way to reduce delay is application of improved technology that will allow existing facilities to be used more fully or that will increase the capacity (service rate) of the airport. The National Airspace System Plan proposed by FAA in January 1982 contains several new technological features that could expedite the movement of traffic into and out of airports.

Among the proposed improvements to the air traffic control system are new, more accurate radar for use in terminal areas, the Microwave Landing System to provide better guidance in reduced visibility, and automated aids to the air traffic controller that will smooth and regulate the streams of arriving and departing aircraft. Implementation of this technology over the remainder of this decade, especially when coupled with revision of separation standards and the rules for use of multiple runways, may yield capacity increases of up to 30 percent at some airports during adverse weather, when the rate of operations is reduced from that attainable in good visibility. These benefits are highly site-specific, however, since they depend on airspace geometry, runway layout, traffic mix, and the prevalence of weather conditions that restrict visibility. The systemwide effects of this new technology are likely to be much smaller and probably would fall in the range of 5 to 10 percent.

These increases, although localized and relatively small in the aggregate, should not be dismissed as insignificant, especially since they would lessen delay just when it is most likely to occur. They would have an effect on congestion and delay at major airports and so would be of significant ben-

Table 5.—Technology To Increase Airport Capacity and Reduce Delay

Airspace and air traffic control	Airport facilities and equipment	Terminal building and equipment	Landside facilities
Improved surveillance radar	Separate runways for small aircraft	Terminal design and configuration	Curbfront access and traffic flow
Microwave Landing System	Improved runway exists and high-speed turnoffs	Passenger movers	Automobile parking
Mode S digital data link	Ground surveillance and control systems	Ticketing and check-in procedures and equipment	Airport circulation roads
Traffic management and flow control	Taxiway marking and lighting	Baggage sorting and handling	Airport access roads
Reduced separation for parallel and converging approaches	Apron and gate facilities	Passenger security screening	Mass transit and modal integration
Wake vortex detection and alleviation	Aircraft servicing equipment	Federal Inspection Service	Remote terminals
Improved weather radar and wind shear detection			
Noise abatement and control			

SOURCE: Office of Technology Assessment.

efit to a large number of passengers. These technological improvements are clearly worth pursuing. But it must be recognized that **the power of technology to relieve airport delay is limited and that adequate future capacity cannot be assured by technology alone.** For instance, advanced aerodynamic design might lessen wake turbulence behind heavy aircraft and thus permit some reduction of separation standards for aircraft in trail, but there are physical limits to how closely an aircraft may safely follow another on the approach path. These limits effectively determine the rate at which aircraft can use the runway, and hence the capacity of the airport.

Increased Capacity

Technology is not the only way to increase capacity. Another method is to add runways at an existing airport or to build a new airport. The constraints, however, are numerous—availability and cost of land, community concern about noise, and the complexity and difficulty of the planning and decisionmaking process.

In general, airport planners and airline passengers prefer that airports be located close to the city. Open land for new airports is not normally available, however, except at considerable distance from the central city, which creates opposition because of the longer travel to and from the airport and the expense of providing rapid access. Proximity to the city and the ability to utilize facilities already in place make expansion of an existing site the more appealing choice. Expansion of an existing airport, however, also presents severe problems because it normally requires purchase of high-cost real estate around the airport site and disruption of residential

Photo credit: Los Angeles Times

and business development that has grown up nearby. In addition, those living near airports resist expansion because of increased highway congestion and aircraft noise around the airport.

Concern about noise has, in fact, become one of the most severe problems faced by airport managers. Any of the options for increasing landings and takeoffs runs a high risk of triggering local opposition because of noise. **Under present policy, airport operators bear sole liability for the damages or nuisance of noise; but because of the complex and fragmented system of authority that governs air transportation, airport managers have only limited ability to control noise and to protect themselves from lawsuit. A view widely held by airport operators and airlines is that a more decisive Federal role is needed to deal with the noise problem.**

One option that receives widespread support is land banking (buying land around the airport) to assure that noise-sensitive development does not occur. Another is economic rent negotiation to provide funds to affected communities to promote land uses that are less disrupted by noise. Federal funds for either purpose would be enthusiastically supported by airport operators, but the Department of Transportation has expressed strong reservations. Another form of relief that would be welcomed by airport operators

is the right to impose restrictions on the time and frequency of flights or, in the absence of such authority, assumption of some liability by airport users and the Federal Government. In theory, airport operators have this right now, but they find it virtually impossible to exercise since they must avoid undue burden on interstate commerce and unjust discrimination among airport users.

Airport Surface Congestion

Delays incurred on the airport surface—on taxiways and at passenger gates—can be as lengthy and costly as those encountered in landing and takeoff. Some of this delay results from inadequate means to monitor and control aircraft movement on the ground, particularly in reduced visibility. This problem could be alleviated with improved radar for surveillance of the airport surface and a traffic control and guidance system akin to that used for airborne flight operations. Aircraft movement could also be expedited on runway turnoffs and exit taxiways—partly through improved design, location, and lighting and partly through measures to encourage pilots to make use of these exit points to clear the runway as promptly as possible.

Perhaps the most common source of delay on the ground, however, is at passenger gates, a problem that arises either from lack of gate facilities or from their inefficient utilization. One way to deal with this is to improve the management of gates. In theory, the airport operator could effectively increase gate capacity by managing all gates as a common pool which could be assigned as needed. This procedure, which is common at large airports in other countries, might be difficult to implement here because it would run counter to existing airline use agreements which grant air carriers long-term leases on gates and control of their use. Additionally, a completely fluid gate assignment scheme might prove logistically impractical for airlines unless commonality could be achieved in their computerized equipment for ticketing and check-in. Another drawback is that passengers might have difficulty locating the proper gate or departure lounge, with the result that delays in the terminal could increase. Nonetheless, the notion of a large, flexible gate pool becomes increasingly attractive as air carriers modify their routes under deregulation, new air carriers come into existence, and the number and role of commuter airlines increases.

The option of increasing the number of gates poses many of the same problems as expanding any other part of the airport complex. Chief among these is the need to build a coalition among the airport's various constituencies to support expansion and reconstruction. Before deregulation, when the major passenger carriers operated on routes assigned by the Civil Aeronautics Board, demand for more gates posed little financial problem. Airline dependability and financial reliability were taken as givens by airport operators and lending institutions, and the airlines themselves were often supportive since gate expansion was perceived as an important part of their long-term presence at an airport. With deregulation, uncertainty

Photo credit: Federal Aviation Administration

has been introduced. Rapidly changing service patterns make it less and less attractive for airlines and airport managers to have large blocks of dedicated gate facilities. Long-term airline tenure may no longer be taken for granted. Startup carriers may not have the financial strength to underwrite development.

If gate expansion to serve major air carriers is difficult, expansion to serve general aviation is even more so. General aviation aircraft owners, even

business fleet operators, pay only a small share of facility construction costs either directly in fees to the airport operator or indirectly through fuel taxes. Consequently, they do not have the leverage on airport construction decisions that is enjoyed by the major air carriers under the terms of the use agreements. In addition, as congestion increases, one of the first proposals is to limit general aviation access to the airport. The prospect that general aviation use of the airport may be substantially reduced as traffic at the airport grows gives investment in general aviation facilities an added uncertainty.

Air cargo carriers also have a weak position in airport investment decisions. Airlines are often reluctant to support investment in new air cargo facilities at an airport unless it will benefit passenger operations directly. Air cargo terminals are also seen by airlines as competitors for space on the airport surface that might be needed for passenger operations. Unlike general aviation, however, air cargo carriers offer airport managers an attractive new customer who can provide substantial revenue. Freight carriers are attractive for two reasons. First, freight transport has grown rapidly and is projected to continue growing. It, therefore, offers a dependable and increasing market. Second, since most freight is handled at night during low traffic periods, freight business can be had without stressing the capacity for passenger operations. However, there is a negative side. Freight carriers create noise at precisely the time when most residents near airports find noise most offensive—at night.

The Terminal Building

The airport terminal—the building itself and the paved areas surrounding it on the airside and the landside—is the zone of transition for passengers, providing the link between surface and air transportation. The design and operation of the terminal have an influence on both airside capacity and ground access and, hence, on the flow of traffic through the airport complex.

Basically, the terminal and associated landside facilities are long-term installations with relatively stable patterns of use. Such facilities are largely independent of the specialized aircraft and airline passenger processing functions that occur on the airside. In contrast, the airside is characterized by short-term, impermanent use that is closely tied to changing aircraft technology that has a useful life of about 10 to 15 years. The essence of good airport terminal design is to strike an appropriate balance between these somewhat contradictory requirements.

The principal effect of the terminal on the airside is through the design of aprons and gates, which determines the number of aircraft that can be accommodated at one time and the turnaround time for passenger boarding and aircraft servicing. The airside impacts of terminal design usually do not extend beyond the apron and gate area, and terminal building char-

acteristics have scant influence on the design of other airside components such as taxiways and runways.

Overall, the influence of the terminal on the functional requirements and performance of airside facilities is relatively small compared to the inverse effect that the airside exerts on the terminal. The primary purpose of the terminal is to transfer passengers and their baggage between surface and air transportation with minimum time, confusion, and inconvenience. The functional requirements and choice of design for a terminal complex must take into account the passenger and baggage flows resulting from aircraft size, traffic mix, schedules of operation, and type of service provided (origin-destination or connecting flights). As a design task, this involves the integration of three major parts of the terminal: airside gates, passenger collection and service areas, and landside access and egress. Since these parts are highly interactive, it is important that the separation between them be kept to a minimum and that traffic flows smoothly among the parts. This would be a fairly straightforward task were it not for the need to design the airside interface so that it can be adapted to accommodate continually changing aircraft technology, airline service patterns, and traffic volumes. At some large hubs, the steadily increasing size of aircraft and their fixed-point servicing requirements, when coupled with growing passenger and automobile traffic, have led to terminal complexes so large and sprawling that they impose burdens of inconvenience and delay on passengers. In response, airport designers have been forced to add an intermediate transportation mode within the terminal itself (moving sidewalks, transport buses, fixed rail systems, and other such people movers) to aid passengers in transferring between the airside and the landside. These systems typically entail large capital investments. Because of their complexity, they may be operationally unreliable and costly to maintain.

Landside

It is a truism that nearly every airplane trip begins and ends with an automobile ride, and there is no clearer manifestation of our dependence on the automobile than at the terminal curbside and on the access roads to the airport. While the figures vary among airports, it is generally estimated that over 90 percent of all airline passenger trips to and from airports are by private automobile or taxi. At medium and small airports, the figure is probably close to 100 percent since these communities tend not to have well-developed public transit capable of providing a practical alternative to the automobile. A further indication of the symbiosis between the airplane and the automobile is the emergence and growth of the car rental industry. This business had its origin in the need for air travelers to have transportation to and from airports in cities away from home. While many car rental firms have since branched out into other markets, the bulk of their business is still rentals to airline passengers, and revenues from this activity are a major source of income for airport operators.

Photo credit: Federal Aviation Administration

Not all trips to and from the airport are made by arriving or departing airline passengers or those who come to meet or drop them off. The automobile is the predominant mode of transportation for airport and airline employees, who account for perhaps one-third of all trips. Trips by delivery firms, service representatives, and others with business on the airport property make up roughly another third of automobile traffic. Many, especially airport workers, come at times when public transit is not available or when service is infrequent, and they have almost no alternative but to drive to the airport and park.

Automobile traffic on the landside is a major source of congestion and delay at airports. Because the funding of landside projects is a complex multijurisdictional arrangement with wide variation from airport to airport, there is no reliable comprehensive estimate of future investment needs. Capital improvements sponsored by FAA are limited to on-airport roadways, guideways, and walkways. These needs are minor compared to parking facilities, access roads, and transportation links to the metropolitan area served by the airport, none of which is eligible for grants from the Airport and Airway Trust Fund. The Federal Highway Administration (FHWA) and the Urban Mass Transportation Administration (UMTA) provide some funds for landside development on the airport property, but the airport operator or local airport authority usually contributes the largest share

Photo credit: Federal Aviation Administration

through retained earnings and revenue bonds. Off the airport property, projects to improve airport access may be eligible for FHWA or UMTA grants, but they must compete with a host of other urban needs.

In general, the solution to airport landside problems is not new technology. Rather, it is a question of management techniques to make better use of the facilities available and construction of new facilities (based on existing technology) to add to landside capacity. In a larger sense, there is also a need to look at the question of airport access from the perspective of the regional transportation system. It is important to find ways of integrating the airport more effectively into the transportation network of the urban area served. Emphasis should be put on approaches to alleviate the problems of traffic flow on the airport property, to reduce the cost and inconvenience of access to the airport from the surrounding metropolitan area, and to facilitate interconnection between air and land modes of transportation.

NOTE: Copies of the full report "Airport System Development" can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, GPO stock No. 052-003-00957-9.

Notes

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